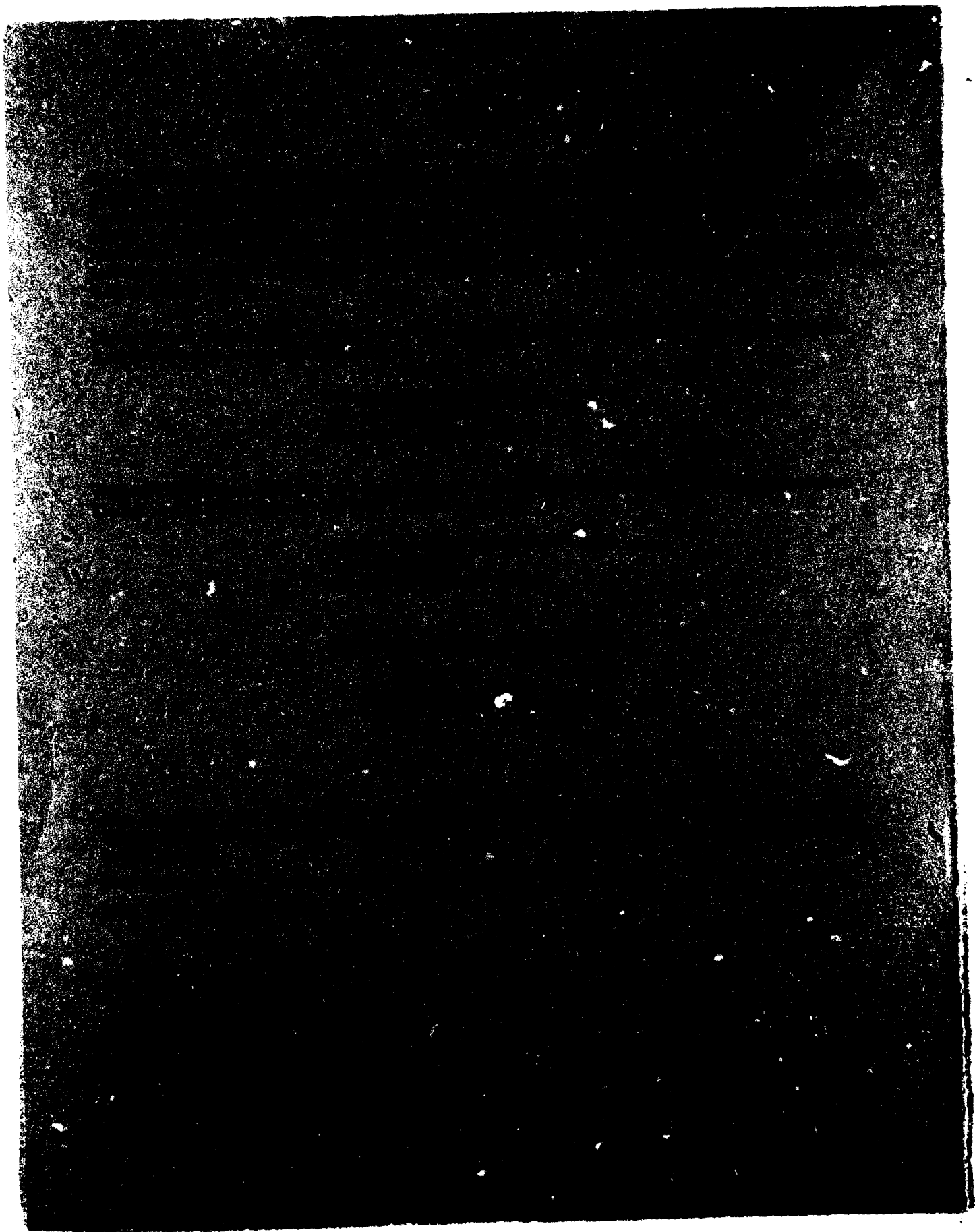


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limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol. 1: Organization, Content and Application," AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

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PREFACE

This report was prepared by the Biodynamic Environment Branch, Air Force Aerospace Medical Research Laboratory, under Project/Task 723108, Crew Safety In Operational Noise Environments.

The author gratefully acknowledges Mr. John N. Cole who assisted in the preparation of this report, Mr. Harald K. Hille for his assistance in data acquisition, Mr. Henry T. Mohlman and Mr. Fred D. Lampley of the University of Dayton for their assistance in the mechanics of data processing, and Mrs. Norma J. Peachey who typed and prepared the graphics.

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INTRODUCTION

The E-4B is a Boeing 747 aircraft modified to serve as the national emergency/HQ Strategic Air Command Airborne Command Post. Power is provided by four General Electric CF6-50E turbofan engines rated at 52,500 lbs. thrust.

This volume provides measured data defining the bioacoustic environments produced inside this aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the E-4B aircraft.

This volume is one of a series published by the Air Force Aerospace Medical Research Laboratory (AFAMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during ground operations of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. Refer to Volume 1 (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., in-flight/flight crew and passenger noise, near-field/ground crew noise, far-field community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AFAMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

Direct any questions concerning the technical data in this report and other handbook volumes to: AFAMRL/BBE, Wright-Patterson AFB, OH 45433; Autovon 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a standard-configured E-4B aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard E-4B environments, but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made at various flight crew and passenger locations. Table 1 lists the *measurement locations and test conditions* as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A.

The microphone position was at ear level external to headgear in a region 0.2-0.3 meter from the head when an individual was present. At unoccupied locations, measurements were made at ear level throughout a volume where the head would normally be located. In both cases, the microphone was randomly moved throughout a spherical volume approximately 0.3 meter in diameter and the resultant samples analyzed using a 4- or 8-second integration time to obtain a power-averaged level which effectively smooths out short-duration fluctuations and best describes the exposure.

Although the presence of a crew member or passenger at a measurement location affects the resultant sound field, the magnitude of such effects is generally small and not significant in determining exposure limits or voice communication capabilities. Consequently, no distinction is made in this report between occupied and unoccupied measurement locations.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the E-4B aircraft at the specified locations. This table includes the overall, 1/3 octave band, and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These variety of measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1
MEASUREMENT AND TEST CONDITIONS

E-4B, Offutt AFB, 28 September 1981
Tail # 125

Location	Position	Height Above Deck
1	Between Pilot and Copilot	Seated Head Level
2	Navigator Station	Seated Head Level
3	Navigator Station (Sextant Operator's Position)	2.4 m
4	Crew Rest Area	1.5 m
5	Crew Rest Area	Seated Head Level
6	Forward Crew Bunk	1.5 m
7	Aft Crew Bunk	1.5 m
8	VIP Lounge - Door Open	Seated Head Level
9	VIP Lounge - Door Closed	Seated Head Level
10	Forward Equipment Room	1.5m
11	Pantry	1.5 m
12	Antenna Room	Seated Head Level
13	Equipment Room/Rm-2 Position	Seated Head Level
14	Data Room (Tech Control)	1.5m
15	VIP Conference Room	Seated Head Level
16	Battle Staff Briefing Area-Table	Seated Head Level
17	Battle Staff Briefing Area-Seats	Seated Head Level
18	Battle Staff Room - Forward Wall	Seated Head Level
19	Battle Staff Room - Aft Wall	Seated Head Level
20	Communication Room - Forward Position	Seated Head Level
21	Communication Room - Aft Position	Seated Head Level
22	Aft Passenger Seats	Seated Head Level
23	Aft Passenger Bunk	1.5 m
24	Tail Passenger Bunk	1.5 m

CONDITION	DESCRIPTION
A	Cruise - 21.5 M, 285 KIAS
B	Cruise - 21.5 M, 285 KIAS, Refueling Door Open
C	Cruise - 21.5 M, 285 KIAS, Refueling Operation
D	Cruise - 33 M, 436 KIAS
E	Cruise - 33 M, 436 KIAS, Antenna Extending
F	Cruise - 33 M, 436 KIAS, Antenna Retracting (Motor Start)
G	Cruise - 33 M, 436 KIAS, Antenna Retracting (Motor Full Speed)

MEASURED SOUND PRESSURE LEVEL (DB)											IDENTIFICATION:	
1/3 OCTAVE BAND											OMEGA 3.2	
											TEST 8Q-000-001	
											RUN 01	
											25 JAN 82	
											PAGE F1	
LOCATION/CONDITION												
FREQ (HZ)	1/A	1/B	1/D	2/A	2/B	2/D	3/D	4/C	4/D	5/D	6/D	7/D
25	69	75	69	67	73	67	65	76	77	75	73	76
31.5	69	74	70	69	74	69	68	76	78	77	73	78
40	64	75	66	66	76	64	66	76	74	77	72	76
50	67	74	66	72	77	65	70	77	75	76	75	74
63	68	82	69	67	83	67	71	82	76	79	79	76
80	67	92	67	64	90	64	68	83	74	74	74	74
100	76	89	78	69	90	66	72	88	75	72	71	73
125	68	88	69	65	88	67	68	89	76	73	70	74
160	69	89	68	66	84	68	70	89	74	74	71	74
200	66	87	65	66	83	65	72	86	72	72	70	73
250	66	85	65	68	83	68	74	85	72	73	72	75
315	67	86	68	73	86	72	80	82	74	77	77	77
400	67	84	67	77	85	70	83	78	73	74	74	74
500	70	84	68	75	81	73	81	77	73	74	74	72
630	71	85	70	72	81	74	77	72	71	72	71	70
800	74	86	72	73	80	76	79	70	69	70	69	68
1000	74	86	72	74	81	74	80	69	67	66	68	67
1250	72	84	72	74	79	73	80	67	64	63	65	63
1600	71	80	70	73	76	72	79	62	58	58	60	58
2000	68	76	67	70	73	73	83	60	57	56	59	58
2500	65	72	66	68	70	71	81	58	53	53	57	57
3150	63	68	65	67	68	72	87	56	52	52	56	56
4000	59	62	60	64	64	70	77	52	48	49	52	56
5000	56	59	59	63	65	67	74	49	46	47	51	54
6300	55	57	58	63	63	68	75	48	45	45	48	54
8000	55	57	59	61	62	69	78	46	45	44	46	51
10000	56	58	59	60	60	67	75	46	44	44	47	49
OVERALL	83	98	83	85	97	85	93	96	86	87	86	87

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

MEASURED SOUND PRESSURE LEVEL (DB)												IDENTIFICATION	
1/3 OCTAVE BAND												OMEGA 3.2	
												TEST 8Q-000-001	
NOISE SOURCE/SUBJECT: (OPERATION:)												RUN 02	
E-4B AIRCRAFT ()													
INFLIGHT NOISE LEVELS ()												25 JAN 82	
()													
()												PAGE F2	
LOCATION/CONDITION													
FREQ	8/C	8/D	9/D	10/D	11/C	12/D	12/E	12/F	12/G	13/F	14/D	14/F	
(HZ)													
25	70	66	62	73	78	79	77	77	77	76	78	79	
31.5	72	66	61	84	76	77	79	78	77	77	82	81	
40	73	67	61	68	78	79	81	79	78	77	78	78	
50	73	62	56	69	80	82	81	80	80	74	71	77	
63	76	69	62	74	83	84	83	84	83	81	79	80	
80	80	59	57	73	82	83	82	87	85	78	74	83	
100	82	62	61	75	83	90	87	88	88	83	77	81	
125	82	61	62	77	81	89	85	87	86	83	75	80	
160	83	66	63	78	79	87	84	85	84	81	75	80	
200	80	62	62	79	80	85	83	87	89	82	72	79	
250	77	60	62	77	79	86	83	88	83	81	71	76	
315	73	61	61	78	75	85	81	88	82	79	69	74	
400	69	59	60	76	73	82	79	82	83	80	66	71	
500	67	59	59	74	72	81	81	86	82	74	64	68	
630	65	59	60	78	70	80	82	85	86	75	64	71	
800	62	59	60	77	69	80	80	84	96	79	64	69	
1000	60	58	58	76	68	81	80	88	84	75	61	65	
1250	56	54	55	75	71	78	78	84	83	71	62	67	
1600	52	50	50	71	63	77	76	84	87	69	60	60	
2000	47	46	47	69	60	76	76	82	82	65	56	59	
2500	43	43	44	67	61	73	73	76	80	63	56	61	
3150	42	41	42	66	61	72	72	76	77	62	59	61	
4000	37	36	35	66	59	69	70	74	75	59	55	53	
5000	35	34	32	65	56	68	71	73	74	59	54	50	
6300	35	33	30	65	55	67	69	71	71	59	56	49	
8000	35	33	30	63	54	66	68	71	73	60	59	50	
10000	36	32	30	63	54	64	67	69	71	62	58	46	
OVERALL	89	76	73	90	91	97	95	98	100	92	88	90	

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)											IDENTIFICATION:
1/3 OCTAVE BAND											
2											OMEGA 3.2
NOISE SOURCE/SUBJECT: (OPERATION:)											TEST 90-000-001
E-4B AIRCRAFT ()											RUN 03
INFLIGHT NOISE LEVELS ()											25 JAN 82
()											()
()											PAGE F3
LOCATION/CONDITION											
FREQ	15/D	16/D	17/D	18/D	19/D	20/D	21/D	22/C	22/D	23/D	24/D
(HZ)											
25	65	76	72	83	82	80	83	96	85	96	83
31.5	65	75	71	83	81	82	84	94	86	84	81
40	71	74	76	88	77	82	76	87	83	83	84
50	70	73	72	80	75	74	72	81	80	81	87
63	71	79	78	86	77	74	72	85	81	84	88
80	67	75	76	82	75	71	73	84	83	84	87
100	68	73	74	78	75	71	75	85	87	83	86
125	67	76	76	77	78	74	75	86	85	82	82
160	66	73	74	75	77	72	73	85	82	80	78
200	66	71	71	74	76	73	70	84	78	77	78
250	66	72	71	73	72	69	66	81	75	75	75
315	66	70	70	72	69	66	65	76	72	73	74
400	65	65	64	69	66	63	61	72	68	71	72
500	65	63	63	68	68	62	59	70	67	68	67
630	64	63	62	66	65	60	58	70	66	68	68
800	63	61	60	65	62	57	56	66	64	66	66
1000	62	60	57	63	59	54	54	63	62	64	65
1250	58	56	54	59	55	50	51	59	58	61	63
1600	52	51	49	53	49	45	47	55	52	56	59
2000	47	49	47	48	46	45	46	53	49	54	55
2500	44	46	43	49	45	44	48	53	48	53	52
3150	43	44	42	47	46	46	50	52	48	53	53
4000	39	41	39	45	44	43	42	50	45	51	53
5000	37	38	37	44	44	44	41	50	45	52	53
6300	36	37	35	43	44	44	40	48	45	51	52
8000	37	37	35	44	43	46	40	47	45	51	52
10000	36	37	35	43	43	45	42	47	45	52	53
OVERALL	79	85	85	93	88	87	88	100	94	93	95

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)											IDENTIFICATION:	
2 OCTAVE BAND) OMEGA 3.2	
) TEST BQ-000-001	
NOISE SOURCE/SUBJECT: (OPERATION:)) RUN 01	
E-4B AIRCRAFT ())	
INFLIGHT NOISE LEVELS ()) 25 JAN 82	
())	
()) PAGE J1	
LOCATION/CONDITION												
	1/A	1/B	1/D	2/A	2/B	2/D	3/D	4/C	4/D	5/D	6/D	7/D
FREQ (HZ)												
31.5	72	79	73	72	79	72	71	81	81	81	77	81
63	72	92	72	73	91	70	74	86	79	92	81	79
125	77	93	78	72	92	72	75	93	80	78	76	78
250	71	91	71	75	83	74	82	89	77	79	79	80
500	74	89	73	80	88	77	86	81	77	78	78	77
1000	78	90	77	78	85	79	84	74	72	72	72	71
2000	73	82	73	76	78	77	86	65	61	61	64	62
4000	65	69	67	70	70	75	87	58	54	54	58	60
8000	60	62	63	66	67	73	81	51	49	49	52	57
OVERALL	83	98	83	85	97	85	93	96	86	97	86	87

(TABLE: MEASURED SOUND PRESSURE LEVEL (DB)													(IDENTIFICATION:
(2 OCTAVE BAND													(OMEGA 3.2
-----) TEST 8Q-000-001
(NOISE SOURCE/SUBJECT:		(OPERATION:											(RUN 02
(E-4B AIRCRAFT		((
(INFLIGHT NOISE LEVELS		((25 JAN 82
(((
(() PAGE J2

LOCATION/CONDITION													
8/C 8/D 9/D 10/D 11/C 12/D 12/E 12/F 12/G 13/F 14/D 14/F													
FREQ													
(HZ)													
31.5 77 71 66 84 82 83 84 83 82 81 84 84													
63 82 70 64 77 86 88 87 89 88 93 82 85													
125 87 68 67 82 86 93 90 91 91 87 80 85													
250 82 65 66 83 83 90 87 92 90 85 75 82													
500 72 64 64 81 76 85 85 89 89 82 70 75													
1000 65 62 63 81 74 84 84 90 96 80 67 72													
2000 53 52 52 74 66 80 80 86 89 71 62 65													
4000 44 43 43 71 64 75 76 79 80 65 61 62													
8000 40 37 34 68 59 71 73 75 76 65 62 53													
OVERALL 89 76 73 90 91 97 95 98 100 92 88 90													

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)											IDENTIFICATION:	
2											OMEGA 3.2	
											TEST 8Q-000-001	
NOISE SOURCE/SUBJECT: (OPERATION:)											RUN 03	
E-48 AIRCRAFT ()												
INFLIGHT NOISE LEVELS ()											25 JAN 62	
()												
()											PAGE J3	
LOCATION/CONDITION												
	15/D	16/D	17/D	18/D	19/D	20/D	21/D	22/C	22/D	23/D	24/D	
FREQ												
(HZ)												
31.5	72	80	78	90	85	86	87	99	89	89	88	
63	75	81	81	88	80	78	77	88	86	88	92	
125	72	79	79	81	81	77	79	90	90	87	88	
250	71	76	75	78	78	75	72	86	80	80	81	
500	69	68	68	73	71	66	64	75	72	74	74	
1000	66	64	62	68	64	59	59	68	67	69	70	
2000	54	54	51	54	52	49	52	58	55	59	61	
4000	45	46	45	50	49	49	51	56	51	57	58	
8000	41	42	40	48	48	50	45	52	50	56	57	
OVERALL	79	85	85	93	88	87	88	100	94	93	95	

TABLE: MEASURES OF HUMAN NOISE EXPOSURE											IDENTIFICATION:
3											OMEGA 3.2
NOISE SOURCE/SUBJECT: (OPERATION:)											TEST 80-000-001
E-4B AIRCRAFT ()											RUN 01
INFLIGHT NOISE LEVELS ()											25 JAN 82
()											PAGE M1
LOCATION/CONDITION											
	1/A	1/B	1/D	2/A	2/B	2/D	3/D	4/C	4/D	5/D	6/D 7/D
HAZARD/PROTECTION											
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR											
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR											
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)											
NO PROTECTION											
OASLC	83	98	83	84	97	84	92	95	85	86	86
OASLA	80	93	80	82	89	84	93	84	77	78	77
T	960	101	960	679	202	480	101	480	960	960	960
MINIMUM QPL EAR MUFFS											
OASLA*	58	75	59	60	74	59	67	73	62	52	61
T	960	960	960	960	960	960	960	960	960	960	960
V-51R EAR PLUGS											
OASLA*	56	69	55	58	67	58	65	63	55	56	56
T	960	960	960	960	960	960	960	960	960	960	960
FLENTS EAR PLUGS											
OASLA*	55	69	54	58	67	57	65	64	56	57	56
T	960	960	960	960	960	960	960	960	960	960	960
H-157 IN-FLIGHT COMMUNICATION UNIT											
OASLA*	60	77	60	61	75	61	69	75	63	63	64
T	960	960	960	960	960	960	960	960	960	960	960
COMMUNICATION											
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)											
PSIL	75	87	74	78	84	78	85	73	70	70	71
ANNOYANCE											
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)											
TONE CORRECTION (C IN DB)											
PNLT	93	103	93	95	102	97	110	97	89	90	91
C	1	0	2	1	0	0	3	0	0	1	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE												IDENTIFICATION:
3												OMEGA 3.2
												TEST 8Q-000-001
NOISE SOURCE/SUBJECT: (OPERATION:)												RUN 02
E-4B AIRCRAFT ()												
INFLIGHT NOISE LEVELS ()												25 JAN 82
()												PAGE H2
LOCATION/CONDITION												
8/C	8/D	9/D	10/D	11/C	12/D	12/E	12/F	12/G	13/F	14/D	14/F	
HAZARD/PROTECTION												
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR												
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR												
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)												
NO PROTECTION												
OASLC	89	75	73	89	90	96	94	98	99	91	86	90
OASLA	76	65	66	84	80	89	89	94	97	84	73	78
T	960	960	960	480	960	202	202	85	50	480	960	960
MINIMUM QPL EAR MUFFS												
OASLA*	67	50	49	65	67	74	71	74	74	68	62	67
T	960	960	960	960	960	960	960	960	960	960	960	960
V-51R EAR PLUGS												
OASLA*	56	43	44	61	58	66	65	70	74	62	52	56
T	960	960	960	960	960	960	960	960	960	960	960	960
FLENTS EAR PLUGS												
OASLA*	57	44	44	61	59	67	65	70	73	62	53	57
T	960	960	960	960	960	960	960	960	960	960	960	960
H-157 IN-FLIGHT COMMUNICATION UNIT												
OASLA*	68	51	51	67	68	75	73	76	76	70	63	68
T	960	960	960	960	960	960	960	960	960	960	960	960
COMMUNICATION												
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)												
PSIL	63	59	60	79	72	83	83	89	91	78	66	71
ANNOYANCE												
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)												
TONE CORRECTION (C IN DB)												
PNLT	90	77	76	96	96	103	102	108	112	98	89	93
C	0	1	0	0	2	1	1	1	3	1	1	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE											IDENTIFICATION:
3											OMEGA 3.2
NOISE SOURCE/SUBJECT: (OPERATION:)											TEST BQ-000-001
E-4B AIRCRAFT ()											RUN 03
INFLIGHT NOISE LEVELS ()											25 JAN 82
()											PAGE H3
LOCATION/CONDITION											
	15/D	16/D	17/D	18/D	19/D	20/D	21/D	22/C	22/D	23/D	24/D
HAZARD/PROTECTION											
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR											
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR											
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)											
NO PROTECTION											
OASLC	79	84	84	91	86	85	66	97	93	32	94
OASLA	70	71	71	74	73	69	68	80	77	77	77
T	960	960	960	960	960	960	960	960	960	960	960
MINIMUM QPL EAR MUFFS											
OASLA*	55	61	61	65	62	59	60	71	70	58	70
T	960	960	960	960	960	960	960	960	960	960	960
V-51R EAR PLUGS											
OASLA*	48	51	50	55	52	49	48	60	56	56	58
T	960	960	960	960	960	960	960	960	960	960	960
FLENTS EAR PLUGS											
OASLA*	49	52	51	56	53	51	50	62	58	57	59
T	960	960	960	960	960	960	960	960	960	960	960
H-157 IN-FLIGHT COMMUNICATION UNIT											
OASLA*	56	62	62	66	63	60	60	72	70	58	70
T	960	960	960	960	960	960	960	960	960	960	960
COMMUNICATION											
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)											
PSIL	63	62	60	65	62	58	58	67	64	67	68
ANNOYANCE											
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)											
TONE CORRECTION (C IN DB)											
PNLT	81	84	84	89	87	83	84	94	93	32	93
C	0	0	0	0	0	0	2	0	1	0	0

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

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